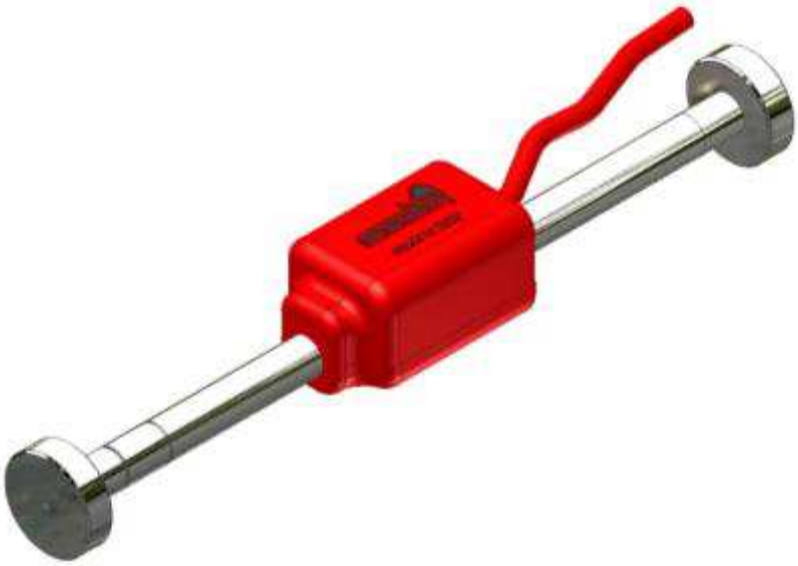
VIBRATING WIRE AND RESISTIVE STRAIN-GAUGES

User Manual



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Notes on the use of product

For a safe and efficient use of the instrument, please read carefully the following instructions before starting any operation.

Any use of the instrument other then the one described in this manual shall be considered at user's full responsibility.
The same applies for any unauthorized modifications.
In addition to the hereby listed standards, the user must comply with the provisions of the current legislation on the matter of personal safety and health of persons in the workplace.
SISGEO is not responsible for any trouble, breakdowns, accidents etc.. due to the lack of knowledge and/or confidence (or non-compliance with) with the requirements contained in this manual.

Check that the instrument has not been damaged during the transport.
Verify that the package includes all items as well as any requested optional accessories; if anything is missing, please promptly contact the manufacturer.
The user must strictly follow all the operations described in this manual.
Maintenance or repair of the instrument is allowed only to authorized operators.
These operators must be physically and intellectually suitable.
For information about instrument or order spare parts request, please always specify data written on the identification label.
When replacing parts, always use ORIGINAL SPARE PARTS.
The manufacturer reserves the right to make changes without prior notice for any technical or commercial requests.
We'll try anyway to keep the manuals updated in order to reflect product's revisions/updates.

Symbols

This symbol will be used used to catch reader's attention on the manual:

Pay special attention to the following instruction.

Identification

Instruments can be identified

- From a production lot number (written on the Compliance Certificate)
- From a serial number *(s/n)* engraved indelibly on the instrument
- From a label on the instrument
- From a label on the cable

Introduction

Strain-gauges measures strain in steel, concrete or reinforced concrete structures. Once integral with the constructions to be monitored, they change the electric signal according to the strains.

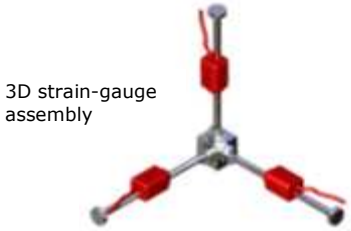
Description

Strain-gauges can be vibrating wire (VW) or resistive.

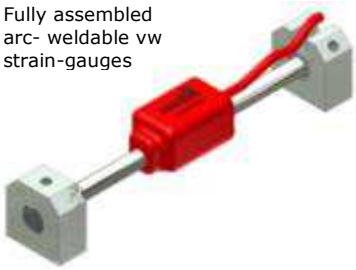
VIBRATING WIRE STRAIN-GAUGES

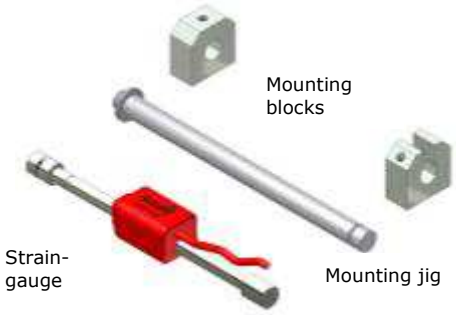
They consist in a hollow cylindrical body with an internal steel wire stretched between the two ends.
Outside, a resin cover protects the coil.
An internal thermistor allows temperature measurement.
VW strain-gauges can be:

1) Embedment VW Strain-Gauges (nominal range ±1500με)



2) Arc-Weldable VW Strain-Gauges (nominal range ±1500με)





3) Embedment VW Strain-Gauges for Shotcrete (nominal range ±5000με)

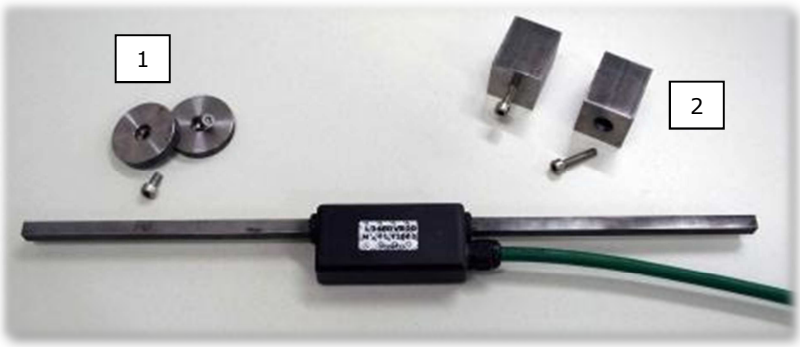
4) No Stress VW Embedment Strain-Gauge (nominal range ±1500με)

They are assembled in an ABS box and embedded in concrete. Since it will not deformed, it is used with other strain-gauges for thermic compensation.

5) Vibrating Wire Rebars (nominal range ±1500με)

RESISTIVE STRAIN-GAUGES

Resistive strain-gauges consist in a squared-section steel rod with 4 extensometers connected in Wheatstone bridge configuration.
They have electric signal 4-20 mA current loop, V/V and V.
Nominal range is ±1500με.
Resistive strain-gauges can be for CLS embedment or arc-weldable.
The instrument is supplied with two discs (1) screwed at the ends, ready for the use.
A pair of optional mounting blocks (2), can be assembled instead of discs, for the welding on metal structures.



Preliminary checks

Before starting the installation we recommend to check the instrument connecting to a portable readout (see "Taking Measurements").

Useful tools:

- Allen key SW3
- iron tie (for embedment type)
- welder (for weldable type)

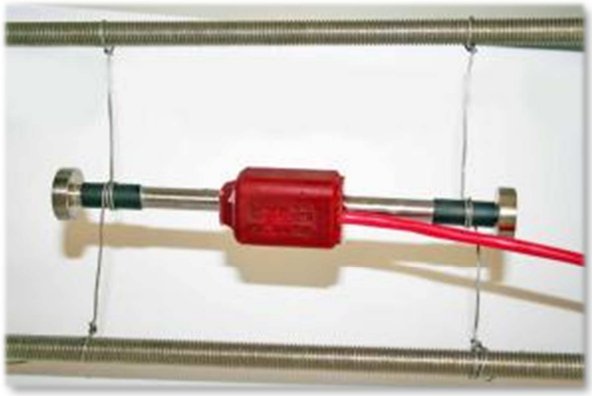
Installation

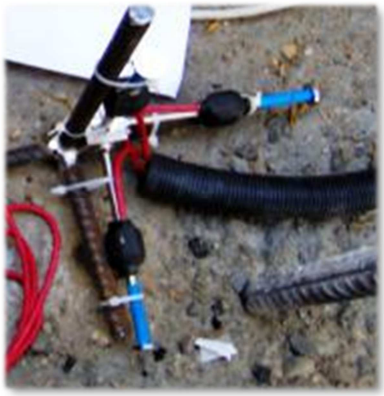
Embedment Strain-Gauges

For the installation proceed as follows:

- Tie the strain-gauges on the rebar so they won't move during the grouting;
- With the vibrating wire model, tie lightly over the black sheath in order to protect the cylinder body.
- Pay attention through the grouting in order to avoid damaging the strain-gauges.
- For the 3D assembly, block the strain gauges on the mounting block with the supplied screws.

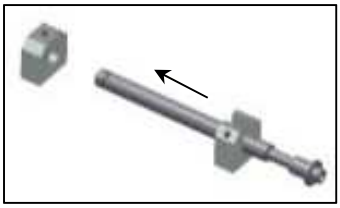
Installation examples:



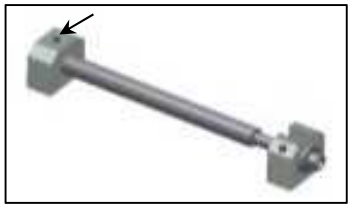


Arc-weldable strain-gauges

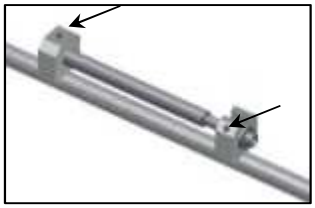
To install please proceed as follows:



Insert the mounting jig in the mounting blocks



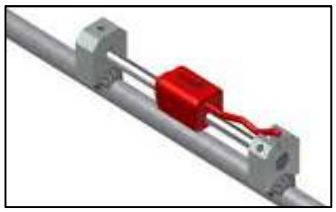
Tighten the first screw



Proceed with the remaining screws until the mounting jig is blocked

Clean the surface and weld the mounting blocks

Once the monting blocks are cold, remove the mounting jig

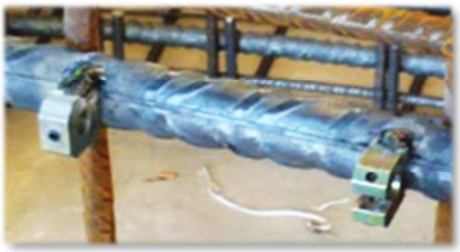


Insert the strain-gauge and block it with the screws

Connect the strain-gauge to the readout and check that the value is approximately 2500με ±10%.
The strain-gauge can be adjusted unscrewing the screws on the open mounting block; once adjusted, tighten the screws.

The strain-gauge has a nominal range of 1000÷4000με.
Do not exceed this values to avoid damaging it irreparably.

Installation examples:



Arc-weldable resistive strain-gauges

To install proceed as follows:

Remove terminal discs

Assemble the mounting blocks on the strain-gauge.

Clean the surface and weld the mounting blocks in the chosen position.

During the welding we recommend to protect the strain-gauge and the cable with a wet rag to avoid heath damaging.

If necessary apply anti-rust paint on the weldings.

Taking measurements

Manual readings are taken connecting the conductors to a readout according to the following scheme:

4-20 mA current loop strain-gauges	Red	+ Loop
	Black	- Loop
VW strain-gauges	Red	VW
	Black	VW
	White	Thermistor
	Green	Thermistor
strain-gauges ratiometric signal (V/V)	Red	+ Vcc
	Black	GND
	Blue	+ Sensing
	Green	- Sensing
	Yellow	+ Out
	White	- Out
Strain-gauges Voltage signal (V)	Red	+ Vcc
	Black	GND
	Yellow	+ Out
	White	- Out

For automatic measures, connect the instrument to a datalogger.

To obtain reliable measures, with 4-20mA instruments, we recommend a warm up time not less than 10 seconds.

Data management

VIBRATING WIRE STRAIN-GAUGES

SISGEO readout provide the deformation measure directly in με.
Conversion is based on the following equation:

$$\mu\varepsilon = \left(f^2 \times 10^{-3}\right) \times G$$

where:

- f: is the wire vibration sequence in Hertz
  G: is the gauge factor that can be obtained from the "Compliance Certificate".

Note: (f^2 x 10^{-3}) is also named "Digit"

G nominal values for the main models are:

- 0VK4100VS00 = 0.391
- 0VK4000VS00 = 4.043
- 0VK4200VC00 = 3.814

The exercise readings refer to the initial zero reading.

$\Delta\mu\varepsilon = L_i - L_0$

L_0 = zero reading (με)
L_i = exercise reading (με)

Zero reading shall be taken carefully once the installation is performed and the instrument is in operating conditions.

Temperature reading

SISGEO readout display the temperature directly in °C.
If the thermistor resistance value is taken, please use the conversion formula in Appendix 1.

RESISTIVE STRAIN-GAUGES

With the resistive strain-gauges, the following formula allows to convert the electric measurements into engineering values:

$L_{ing} = L_{ele}/S$ [με]

L_{ing} = engineering reading
L_{ele} = electric reading
S = sensitivity factor (obtained from Compliance Certificate)

Troubleshooting

Vibrating wire strain-gauges

Problem	Possible cause	Solution
Measure not stable	Instrument out of range	None
	Cable shield not connected	Connect the shield
	Electromagnetic fields generated by engines, generators, antennas, welders or high voltage lines nearby	Identify and remove the cause. Shield the signal cable.
	Insulation loss	None
	Grounding not well done	Provide efficient grounding
Wire not detected	Cable cut or damaged. Measure the resistance between the red and black conductors. Acceptable values : 160Ω ± 10%. Consider cable length.	Repair the cable: cable splicing kit is available at SISGEO.
	Uncorrect wiring	Make proper wiring

Resistive strain-gauges

Problem	Possible cause	Solution
Unstable measure 0mA measure Overrange measure	Uncorrect wiring	Make proper wiring
	Cable cut or damaged	Repair the cable. Cable splicing kit available at SISGEO.

Maintenance

After-sales assistance for calibrations, maintenance and repairs, is performed by SISGEO's service department.
The authorization of shipment shall be activated by RMA "Return Manufacturer Authorization". Fill in the RMA module clicking on:

http://www.sisgeo.com/en/assistance/repairs/

Send back the instrument/equipment with the complete accessories, using suitable packaging, or, even better, the original ones.
The shipping costs shall be covered by the sender.

Please return to the following address with suitable delivery document:

SISGEO S.r.l.
Via F.Serpero, 4/F1
20060 MASATE (MI)

On the delivery document is mandatory to indicate the RMA code received.

Technical assistance e-mail: assistance@sisgeo.com

Appendix 1

THERMISTOR TEMPERATURE CONVERSION

Resistance to temperature equation:

$$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.2$$

Where:
T= temperature in °C
LnR= natural Log of the thermistor resistance
A= 1.4051×10^{-3} (coefficents calculated over the -50 to +70°C span)
B= 2.369×10^{-4}
C=1.019×10^{-7}

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
16.60K	-10	5971	10	2417	30	1081	50
15.72K	-9	5692	11	2317	31	1040	51
14.90K	-8	5427	12	2221	32	1002	52
14.12K	-7	5177	13	2130	33	965.0	53
13.39K	-6	4939	14	2042	34	929.6	54
12.70K	-5	4714	15	1959	35	895.8	55
12.05K	-4	4500	16	1880	36	863.3	56
11.44K	-3	4297	17	1805	37	832.2	57
10.86K	-2	4105	18	1733	38	802.3	58
10.31K	-1	3922	19	1664	39	773.7	59
9796	0	3784	20	1598	40	746.3	60
9310	-1	3583	21	1535	41	719.9	61
8851	2	3426	22	1475	42	694.7	62
8417	3	3277	23	1418	43	670.4	63
8006	4	3135	24	1363	44	647.1	64
7618	5	3000	25	1310	45	624.7	65
7252	6	2872	26	1260	46	603.3	66
6905	7	2750	27	1212	47	582.6	67
6576	8	2633	28	1167	48	562.8	68
6265	9	2523	29	1123	49	543.7	69
						525.4	70